

REMARKS

Claims 1-10 and 12-13 are pending. Claim 11 has been canceled without prejudice.

Claim 1 has been amended to recite that the rhodium catalyst is homogeneous as it is in the presence of the reaction between methanol and carbon monoxide. There is written description support for this description at page 18, last 4 lines wherein the rhodium is taught to be "a rhodium complex soluble in the reaction mixture under reaction conditions."

New claim 12 is similar to claim 1 except that new claim 12 describes the rhodium catalyst using the language found at page 18, last 4 lines.

New claim 13 recites a range of hydrogen partial pressure of 30-100 kPa. Support for this range can be found in combining the range of "100 kPa or less" with the endpoint of 0.03 MPa (equivalent to 30 kPa) as disclosed in Example 3 (see page 39, last line of the present specification).

No new matter has been added by way of the above-amendment. In view of the above amendment, Applicant believes the pending application is in condition for allowance.

Prior art based issues

The following prior art based rejections are pending:

- (A) Claims 1-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hosono et al. (US 20060281944, US '944 *equivalent to JP2004277297*) in view of Scates et al. (US6303813, US '813 *equivalent to JP2003508363*) or Jones (US7098363, US '363 *equivalent to JP2002508759*) *all in IDS and ISR*, further in view of and Miura et al. (EP0687662, EP '662 *equivalent to US5625095 in ISR*); *and*
- (B) Claims 9-10 are rejected under 35 U.S.C. 103(a) as being unpatentable as being unpatentable over US '944 in view of US '813 or US '363, further in view of EP '662, as applied to claims 1-7 above, and further in view of Cheung et al. (US7005541, US '541).

Applicants respectfully traverse both Rejection A and B.

The present invention is drawn to a method for producing acetic acid by continuously reacting methanol with carbon monoxide in the presence of a rhodium catalyst, an iodide salt, methyl iodide, methyl acetate, and water. The inventive method has the advantage that it produces acetic acid at a production rate of 11 mol/L·hr or more while keeping the acetaldehyde low. In fact, the acetaldehyde is kept to 500 ppm or less in the reaction mixture. Also, by keeping the methyl acetate content of the reaction mixture to 2 percent by weight or more, the inventive method is able to keep the ratio of the production rate of acetaldehyde to acetic acid to be 1/1500 or less. In addition, the reaction is carried out at a carbon monoxide partial pressure in a gaseous phase of a reactor of 1.05 MPa or more.

In order to further distinguish the inventive method from the teachings of the cited references, Applicants have amended claim 1 to recite that the rhodium catalyst is *homogeneous*. The use of a homogeneous catalyst in the conditions set forth in inventive claim 1 has advantages which are not seen in the cited prior art.

We now turn to the cited prior art.

US '944 teaches that the technical field of their invention is as follows:

This invention relates to a method of manufacturing acetic acid. More particularly, the present invention relates to a method of manufacturing acetic acid by carbonylating methanol with carbon monoxide in a bubble column reactor in the presence of a *solid catalyst*, the reaction being conducted with a high catalyst concentration. (Emphasis added).

Thus, catalysts which are taught and described in US '944 are solid catalysts which are heterogeneous catalysts, not homogeneous catalysts as in the present invention. US '944 teaches a completely different set of reaction conditions to conduct the heterogeneous catalysis than is used in the present method. Also, US '944 requires apparatus designed to work with a heterogeneous catalyst. This difference is described in paragraphs [0002] to [0007] of US '944. A reference which leads one of ordinary skill in the art away from the claimed invention cannot render it unpatentably obvious. *Dow Chem. Co. v. American Cyanamid Co.* 816 F2d 617, (CAFC 1987). In determining the scope and content of the prior art, and determining whether

the prior art suggested the claimed invention, the references "must be read as a whole and consideration must be given where the references diverge and teach away from the claimed invention." *Akzo N.V. v. United States Int'l Trade Comm'n*, 1 USPQ2d 1241, 1246 (Fed. Cir. 1986); *In re Fine*, 5 USPQ2d 1596, 1598-99 (Fed. Cir. 1988). Known disadvantages in old devices which would naturally discourage the search for new inventions may be taken into account in determining obviousness. *United States v. Adams*, 383, U.S. 39, 52 (1966).

In the present case, it would be impossible to apply the heterogeneous catalysis reaction of US '944 to the inventive homogeneous catalysis reaction. Accordingly, significant patentable distinctions exist between the present method and the teachings of US '944.

The Examiner, aware that US '944 fails to teach or fairly suggest the features of inventive claim 1, cites US '813, US '363, EP '662 and US '541 in order to cure these deficiencies. However, Applicants respectfully submit that US '813, US '363, EP '662 and US '541 do not cure the deficiencies discussed above with respect to the method described in inventive claim 1.

US '813 discloses that the production of carbonyl impurities should be decreased by maintaining the hydrogen partial pressure at 0.1-4 psi (equivalent to 0.7 to 27.6 kPa) under low water concentrations, see column 3, line 4 of US '813. However, the present inventors have found that it is difficult to achieve sufficient activity of the catalyst in a process for producing acetic acid and the amount of acetic acid which is capable of being produced deteriorates when the hydrogen partial pressure is exceptionally low (see page 3, lines 1 to 8 in the present specification wherein the JP2003508363 which the Examiner finds is the equivalent to US '813 is discussed). Therefore, it is impossible using the conditions of US '813 to achieve the production rate of acetic acid of 11 mol/L·hr or more while keeping the ratio of the production rate of acetaldehyde to acetic acid to be 1/1500 or less as presently claimed.

US '363 describes the invention in the Abstract as follows:

A process for the production of a product comprising a carboxylic acid having n+1 carbon atoms which process comprises reacting in the liquid phase at elevated temperature and pressure a composition comprising an alcohol having n carbon atoms and/or a reactive derivative thereof, a halogen and/or a halogen compound promoter, water and carbon monoxide in the presence of hydrogen and a heterogeneous catalyst

comprising a Group VIII noble metal species on a polymeric resin having a functional group selected from nitrogen-containing heterocycles. (Emphasis added).

It is clear that US '363 requires the use of a heterogeneous catalyst. As such, US '363 does not cure the deficiencies of US '944 as discussed above.

The Examiner relies on EP '662 for disclosing that the acetaldehyde content of the reaction mixture should be maintained to 400 ppm or less. In order to accomplish this, EP '662: a) removes the acetaldehyde from the reaction liquid circulating in the reactor (page 2 lines 15 to 25); b) raises the hydrogen partial pressure; c) raises the water concentrations; and d) raises the rhodium content. However, EP '662 does not disclose that the main reaction can be facilitated while inhibiting the side reaction by controlling the methyl acetate content of the reaction mixture and the partial pressure in the gaseous phase of the reactor (see Table 1 and page 13 lines 17 to 19 of the present specification), as presently claimed. As such, EP '662 does not cure the deficiencies of US '944.

Additionally, the inventors of the present invention have studied and made the following Observations i-ii.

Observation i - In US '813 and US '541, the reaction is carried out at a low water concentration. However, the water-gas-shift reaction rate slows down and the hydrogen partial pressure reduces at such a low water concentration.

Observation ii - A low hydrogen partial pressure would also make the production rate of acetic acid reduce, and would reduce the hydrogenation reaction rate of acetaldehyde. Accordingly, the acetaldehyde content in the reaction mixture would elevate, and the condensation reaction rate of acetaldehyde would increase.

As a result, under the conditions of US '813 and US '541, the production of reducible components (impurities) such as crotonaldehyde and 2-ethylcrotonaldehyde would increase by the acetaldehyde undergoing additional unwanted reaction(s). As such, the reaction product has a worse test value in the potassium permanganate test.

The present invention is the result of intensive studies by the inventors who found the best conditions in which the production of the by-product is inhibited while keeping the production rate of acetic acid high, even under a low hydrogen partial pressure.

For example, US '813 teaches that the partial pressure of carbon monoxide is typically about 2 to 30 atm (0.2 to 3MPa), preferably 4 to 15 atm (0.4 to 1.5 MPa). However, using the examples of the present specification as a guide, it is clear that the acetaldehyde-STY would be extremely high in the reaction mixture of US '813, based on the comparative examples in the present specification which were run under a partial pressure of carbon monoxide of 0.97 MPa and 1.0 MPa (Comparative Examples). In the former case (0.97 MPa), the acetaldehyde/acetic acid ratio of production rate is 600 to 1200, and in the latter case (1.0 MPa), the ratio is 3600 to 10000.

On the other hand, the present inventors have shown that the acetaldehyde-STY can be made low (concretely 2.3 to 4.3 mmol/L/hr) when the partial pressure of carbon monoxide is 1.2 MPa to 1.8 MPa (see Examples 1-3 of the present specification).

In fact, even though the production rate of acetic acid of the present invention is equivalent to that of US '813, the production rate of acetaldehyde varies greatly depending on respective condition.

Furthermore, the present inventors have found that when the methyl acetate content is 1.3 wt% or 1.6 wt%, the production of acetaldehyde is high. However, when the methyl acetate content is raised to at least 2wt% as presently claimed, the production of acetaldehyde is small. See Table 2 on page 46 of the present specification.


In summary, the inventive method efficiently produces high-purity acetic acid, which method can increase the productivity of acetic acid and reduce the production of by-products by controlling the partial pressure of carbon monoxide and methyl acetate content. These advantages are neither taught nor fairly suggested by the cited art. As such, withdrawal of Rejections A and B is respectfully requested.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Garth M. Dahlen, Reg. No. 43,575 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37.C.F.R. §§1.16 or 1.147; particularly, extension of time fees.

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Respectfully submitted,

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